"Importance of spatial and depth-dependent drivers in groundwater level modeling through machine learning" by Pragnaditya Malakar, Abhijit Mukherjee, Soumendra N. Bhanja, Dipankar Saha, Ranjan Kumar Ray, Sudeshna Sarkar, Anwar Zahid

Prof. Lahcen Benaabidate's Comment:

The authors have treated an interesting topic dealing with groundwater in a large transboundary aquifer between India and Bangladesh for the purpose of highlighting the influence of various triggers; natural and anthropogenic that act and harm this groundwater. The investigation is carried out by the use of machine learning methods (support vector machines and artificial neural network The application of this kind of modeling constitutes a novelty for groundwater in the studied basin. The title is appropriate for the content of the paper, however, it will be better if they add an indication about the study area. The abstract summarizes the main information of the paper and highlights the main finding. The paper is well written and balanced. However, the article contains imperfections such as:

Reply: We thank Prof. Lahcen Benaabidate for his review and support for the general intent of the paper. We appreciate that the appended comments are helpful and intended to improve the manuscript. We have addressed the reviewer's comments, and we believe these have greatly improved the manuscript.

Highlights of the revision:

We have

   a) Provided the appropriate citations in the text and in the supplementary information.
   b) Addressed the high groundwater abstraction in southeast India (Bengal basin)
   c) Maintained an alphabetical order in the reference list
   d) Corrected the typos

SC1. Comment 1: The authors repeatedly cited Figures S1 up to S17 (line 263) and Tables S1 to S11 (example line 282, 283) but in the list of figures and tables below those illustrations are missing.

Reply: Thank you, Prof. Lahcen Benaabidate, for the comment. Figure S1 to S17 and Table S1 to S11 are supplementary figures and tables, which can be found in the supplementary information

section. Please find the supplementary information (https://hess.copernicus.org/preprints/hess-2020-208/hess-2020-208-supplement.pdf).

SC1. Comment 2: Line 47 they wrote: south-east India (Bengal basin), maybe they rather say North-east India.

Reply: We thank Prof. Benaabidate for the suggestions.

We would like to mention that in addition to severe groundwater depletion in northwest India, the Bengal basin in southeast India also suffered from pervasive groundwater abstraction in the recent past, reported by Mukherjee et al. (2007), Macdonald et al. (2015), Macdonald et al. (2016), Lapworth er al. (2018). Following the reviewer's suggestions, we have mentioned appropriate references in the text.

"As a result of the pervasive groundwater withdrawals, IGBM experiences rapid groundwater depletion, predominantly in northwest India (Rodell et al., 2009), southeast India (Bengal basin) (Mukherjee et al., 2007, Macdonald et al., 2015, Macdonald et al., 2016, Lapworth er al., 2018), and the Meghna basin in Bangladesh (Shamsudduha et al., 2011; MacDonald et al., 2016)."

SC1. Comment 3: Line 49, do "Summer" and "winter" correspond to "Rabi" and "Kharif" respectively.

Reply: We thank the reviewer for noticing the typo. Following the reviewer's comment, we have modified the text.

"These densely populated agricultural regions of IGBM are dependent on the groundwater-fed irrigation for crop production, primarily for the summer season (i.e., Kharif) and winter season (i.e., Rabi) crops (World Bank, 2010)."

SC1. Comment 4: Line 54, could you give value for the population?

Reply. Thank you. We have added the population and appropriate citation.

"Thus, posing a severe threat to water sustainability for more than 1 billion people (Mukherjee, 2018) in South-Asia."

SC1. Comment 5: Line 166, authors should add a reference.

Reply: Following Prof. Benaabidate's suggestion, we have mentioned appropriate reference in the text.

We added,

"ANN is a data-driven computational method, which follows the biological neural system (Rajaee et al., 2019)."

SC1. Comment 6: In all the manuscript, when a cardinal point is preceded by "the" the first letter should be written in capital letter.

Reply: Thank you for the comment.

SC1. Comment 7: Line 349, it's better to change "Please" » by "we".

Reply: Thank you, Prof. Benaabidate's. Following your suggestion, we have modified the sentence.

We modified,

"We note that water use may not be strongly correlated to population, especially in rural areas, where pumping for irrigation is not necessarily linked to population."

SC1. Comment 8: In the reference list, the citations should be written in the alphabetic order.

Reply: We thank Prof. Benaabidate for the comment.

Following the comment, we have maintained an alphabetical order in the reference list.

SC1. Comment 9: For some references with the same first author, they should be classified ..YEARa, YEARb…, example "Bhandri et al, 2019".

Reply: We thank Prof. Benaabidate for the comment.

Following the comment, we have maintained the order in the reference list.

SC1. Comment 10: There is a disagreement between some references in the test and in the list, example Youn et al, 2016 and in the list 2011. BADC, 2017 in the text and 2014 in the list.

Reply: Thank you, Prof. Benaabidate for the comment.

Yoon et al., 2011 and Yoon et al., 2016 both are cited in the text. Accordingly, they were added to the reference list.

Thank you for noticing the typo. Following the reviewer's comment, we have corrected the typo.

"For Bangladesh, the groundwater withdrawals data were derived by integrating data from local and published datasets (AQUASTAT, 2018; Bangladesh Agricultural Development Corporation, 2014) (Table S3)."

References

Bangladesh Agricultural Development Corporation. Minor Irrigation Survey report, 2013 – 14. Govt. of Bangladesh, Dhaka, 2014

SC1. Comment 11: The reference SEDAC, 2018 is missing n the list.

Reply: Thank you for the comment.

SEDEC is referenced under the recommended reference of the population data documentation, i.e., Palisades NY: NASA Socioeconomic Data and Applications Center (SEDAC)

which is,

Palisades NY: NASA Socioeconomic Data and Applications Center (SEDAC): Documentation for the Gridded Population of the 505 World, Version 4 (GPWv4), Revision 11 Data Sets, Cent. Int. Earth Sci. Inf. Netw. (CIESIN), Columbia Univ. 2018, III (845), 224–234, doi:https://doi.org/10.7927/H45Q4T5F, 2018.

SC1. Comment 12: The reference Bhanja et al, 2017 is missing in the list.

Reply: Thank you for noticing the typo. Following the reviewer's comment, we have corrected the typo in the text.

"The uncontrolled irrigation practices (Barik et al., 2016; Bhanja et al., 2017a) lead to the over-exploitation of the aquifers in the IGBM, which is reflected in the deepening of GWL in northwest India, Meghna basin in Bangladesh, western Ganges basin and Bengal basin part of Ganges basin in the east (Figure 1b)."

Reference

Bhanja, S. N., Mukherjee, A., Rodell, M., Wada, Y., Chattopadhyay, S., Velicogna, I., Pangaluru, K. and Famiglietti, J. S.: Groundwater rejuvenation in parts of India influenced by water-policy change implementation, Sci. Rep., 7(1), 7453, doi:10.1038/s41598-017-07058-2, 2017a.

SC1. Comment 13: In conclusion, I recommend that this paper will be accepted after minor revisions.

Reply: We thank Prof. Benaabidate for his appreciation of the manuscript.